and the rate indicated by the Signal Corps formula if the constant of 72 is adopted and the additions are made to the first five minutes:

Minute.	Mr. Batty's observed rate (m. p. m.).	Signal Corps rate (m. p. m.).
1	181	181.9
2	163	166.9
3	164	166.9
4	159	159.3
5	157	159.3
Mean from 5 to 10 minutes	153.2	151.6

The agreement in this table is remarkably close, and strongly confirms the accuracy of the newly determined constant, as well as the necessity of introducing additive corrections during the first five minutes.

A REPORT ON TWO PILOT-BALLOON ASCENTS MADE AT SHOEBURYNESS.[1]

By N. K. JOHNSON.

(Review reprinted from *The Meteorological Magazine*, London, Dec., 1920., p. 247.)

In the two ascents to which this note is devoted, the pilot balloons were followed with two theodolites and also with a range finder. It so happened that in each case the balloon developed a defect after reaching 25,000 or 30,000 feet; the first dropped rather quickly, the second very slowly. The usual assumption of the single-theodolite method, that the rate of ascent was uniform, would have led to entirely false results, the wind being credited with speed of 100 feet per second at 60,000 feet.

The principal moral of the paper is that when information as to air currents at considerable heights is derived from the one-theodolite method it must be used with the greatest caution; it also brings out how much is to be learned concerning the structure of the atmosphere by the more elaborate two-theodolite method.

VISIBILITY OF PILOT BALLOONS.

By NELSON K. JOHNSON.

[Abstracted from the Meteorological Magazine, December, 1920. Vol. 55, pp. 249-251.]

In order to determine the most suitable color for pilot balloons under various atmospheric conditions, four ascents were made at Shoeburyness, two differently-colored balloons, tied together with about 20 feet of thread, being used in each ascent. In each of the first three cases a red and a white balloon were used, blue having already been found unsatisfactory except against a dense white background. In the fourth ascent a plain white balloon and another white one coated with aluminum paint were used. This treatment was not effective, because the paint dried a drab gray without any metallic luster. The suggestion is made, however, that if pilot balloons can be coated in the same manner as are kite balloons, both their opacity and their reflecting power would be increased. In the three ascents with red and white balloons it was found that the white ones are best in sunshine because of their greater reflecting power, and the red in cloudy weather because of their greater opacity.

The author summarizes his results as follows:

"(1) Against a background of continuous, dense white cloud either red or blue should be used.

[1] *Professional Notes, No. 13.* Brit. Meteorological Office publication.

"(2) If the sky contains slight cirrus or haze, red is the correct color to employ.

"(3) On occasions on which the sky is cloudless and of a deep blue color, a white balloon should be selected."—*W. R. G.*

VERTICAL CURRENT DETECTED BY COMPARING CLOUD MOTION WITH APPARENT SPEED OF PILOT BALLOON.

By JOSEPH LESHAN.

[Weather Bureau, Washington, D. C., Dec. 22, 1920.]

SYNOPSIS.

The pilot balloon ascension made at Washington, D. C., on the afternoon of November 23, 1920, showed a rapid rise in velocity up to the 800-meter level, and an almost equally rapid decline thereafter to the 1,800-meter level, when the balloon entered a roll of strato-cumulus cloud. The appearance of the clouds and a nephoscope observation made at that time seem to show that the balloon gained about 100 meters during the last minute of ascension over the assumed rate of ascent, and that the velocity during the last minute should be corrected from 6.2 to 13.3 meters per second.

A comparison of the altitude-velocity curve for this ascension (the heavy line in the figure) with other altitude-velocity curves for ascensions in the vicinity taken within eight hours, shows that all but one of the

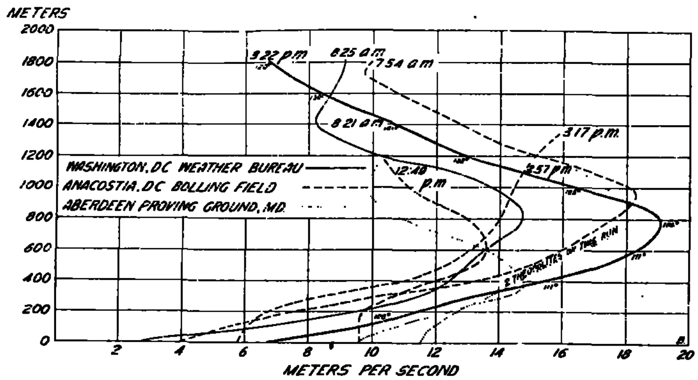

FIG. 1.—Altitude-velocity graphs for pilot balloon observations, Nov. 23, 1920. Wind directions at Washington are indicated at every 200 meters (0° = S., 90° = W.).

curves have approximately the same general characteristics except that none of them reaches as high a velocity at its maximum, nor does any of them reach as low a velocity at its minimum.

The reason for the peculiar features of the curve in question might be explained by the supposition that the balloon was in a downward current of air up to about the 800-meter level, and in an upward current during the latter part of the flight. Such currents in a single theodolite system of observation would give higher and lower computed velocities respectively.

The appearance of the lowest strato-cumulus cloud-layer at the time of observation would tend to bear out this supposition, as the clouds were in bands lying approximately northeast-southwest, and were probably formed on the crests of an air wave moving approximately from the northwest. It can be easily seen that with the balloon in the downward current of the wave the angle would be depressed and give a greater computed velocity, and conversely with the balloon in the ascending portion of the wave.

Nephoscope readings at the time of the observation indicated that the cloud which the balloon entered was moving at the rate of 7 meters per second for every thousand meters of elevation. While it is not certain that the cloud which the balloon entered was the same as that observed in the nephoscope, and while it is not certain that the cloud entered was part of the lowest layer of strato-cumulus, the circumstances seem to justify the assumption that the nephoscope observation is applicable to the place where the balloon disappeared. In the first place the direction of motion of the cloud as observed was from 122° and that of the balloon during the last minute of flight was from 120°. Above this lowest (?) series of strato-cumulus bands were two others; the next higher (?) one was from 130 to 135° at a speed of 5.9 to 6.4 m/s for each kilometer of elevation, and the highest (?) was from 130° at a speed of 3.7 m/s for each kilometer of elevation. It was estimated at the time that the highest layer was at about 3 kilometers.

Assuming that the balloon entered the lowest layer of strato-cumulus, which were moving at the rate of 7 m/s for every thousand feet of elevation, it should have been moving at the rate of 12.6 m/s at the 1,800 meter level (the assumed altitude). If it had been moving at that rate, however, during the last minute of flight, it would have been carried out to a point 756 meters beyond where it was at the end of the eighth minute, or to a point 7,416 meters from the station. At that point, with an elevation angle of 14.3° as observed, the height of the balloon would have been 1,890 meters, which in turn would give us a velocity of 13.2 m/s, as the nephoscope readings indicated a velocity of 7 m/s for every kilometer of elevation.

Assuming a velocity of 13.2 m/s we carry the approximation one step farther, and obtain a distance out of 7,452 meters, an altitude of 1,900 meters, and a velocity of 13.3 m/s. Further approximations do not materially alter this result.

Since the balloon was so inflated as to reach 1,800 meters in 9 minutes under ordinary conditions, it appears to have gained 100 meters during the last minute of its flight on account of ascensional air currents.

A CONTRIBUTION TO THE METEOROLOGY OF THE ENGLISH CHANNEL.

By HUGH D. GRANT.

[Noted from *The Aeronautical Journal*, January, 1921, pp. 25-38.]

Owing to the notorious capriciousness of the weather of the English Channel, and to the vast dependence of transchannel navigation, both marine and aerial, upon these vagaries, this study has been made. It is an attempt to analyze the barometric disturbances which give rise to the channel weather, and the relation of the topography to the sudden changes which occur. Winds, in mid-channel and along the coast, were studied; the latter were investigated by means of pilot balloons which were filled so as to be in equilibrium in the surface air, and by this means a very good idea of the turbulence and gusts along the steep cliffs between Dover and Folkestone was obtained. Fogs, thunderstorms, gales, and squalls are also considered. It is pointed out that the number of well-equipped observatories and dense population on both sides of the channel afford unusual advantages to the investigator, owing to the large number of voluntary observers.—*C. L. M.*

PILOT-BALLOON WORK IN CANADA.

By J. PATTERSON.

[Presented before the American Meteorological Society, Chicago, Dec. 28, 1920.]

(Author's Abstract.)

The Meteorological Service of Canada in conjunction with the Air Board of Canada has established a series of pilot-balloon stations across the country. Last year stations were opened at Vancouver, British Columbia, Morley Alta (near Calgary), Camp Borton, Toronto, and Ottawa, Ontario, and Roberval (Lake St. John), Quebec. It is the intention to open stations this spring at Peace River Crossing and Fort Good Hope on the MacKenzie River. The one theodolite method was used and results plotted in the usual way.

THE MAKING OF UPPER-AIR PRESSURE MAPS FROM OBSERVED WIND VELOCITIES.[1]

By C. LEROY MEISINGER.

[Weather Bureau, Washington, D. C., Nov. 27, 1920.]

SYNOPSIS.

If the equation which expresses the relation between the speed of the wind and the distribution of barometric pressure be solved for the gradient in terms of the observed speed, density of the air, radius of curvature of the wind path, and latitude, it is possible to work out a fairly accurate map of the distribution of barometric pressure at upper levels. This has been done for the observations made about 8 a. m., March 27, 1920, at most of the aerological stations of the Weather Bureau and the Signal Corps. The pressures observed by kites, when used in connection with the computed gradients, give the clue to the values of the absolute pressures at the level in question. Maps of the 1, 2, and 3 kilometer levels were thus constructed.

The gradient wind.—If it is assumed, as is usually justifiable, that the effect of the friction of the earth's surface is negligible at about 500 meters above the surface, it should be possible to use observed wind velocities as a basis for determining the distribution of pressure aloft. The gradient wind equation is frequently used to determine the speed of the wind, using as a basis the sea-level distribution of pressure, but it is obvious that, by solving the equation for the gradient in terms of the speed, the density of the air, the radius of curvature of the wind path, and the latitude, an accurate upper-air map ought to result if based upon sufficient observations. Pilot-balloon observations give only wind speed and direction at various heights; and with these data alone it is possible to determine the gradient but not the absolute pressure. This deficiency may be supplied by kite observations which, when reduced, give the absolute value of the pressure at various levels. Since wind direction is an index to the direction of the isobar and, therefore, the gradient, (the latter being normal to the former) we are enabled to determine quite accurately the radius of curvature of the path. The density may be determined from kite data also. Thus we have all the necessary values to substitute in the equation.

If we take the three equations for the velocity of the gradient wind, as given by Dr. W. J. Humphreys,[2] namely:

(1) . . . $v=\sqrt{\frac{r}{\rho}\frac{dp}{dn}+(r\omega\sin\phi)^2}-r\omega\sin\phi$ for cyclones;

(2) . . . $v=\frac{\frac{dp}{dn}}{2\omega\rho\sin\phi}$ for straight isobars;

(3) . . . $v=r\omega\sin\phi-\sqrt{(r\omega\sin\phi)^2-\frac{r}{\rho}\frac{dp}{dn}}$ for anticyclones, and solve them for $\frac{dp}{dn}$, we obtain, respectively,

[1] Presented before the American Meteorological Society at Chicago, Dec. 28, 1920.

[2] *The Physics of the Air*, Franklin Institute, 1920, pp. 139-140.